OIPE JC17
MAR 1 1 2002
PATENT & TRADEMARK OFFICE

2878

2800 · 0360

COPY OF PAPERS ORIGINALLY FILED

Attorney's Docket No.: 774-010704-US(PAR)

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): LAM et al.
Serial No.: 10/006,752
Filed: 11/08/01
For: AN OPTICAL COUPLING MOUNT

Group No.:

Examiner:

Commissioner of Patents
Washington, D.C. 20231

RECEIVED
APR 03 2002
TC 2800 MAIL ROOM

TRANSMITTAL OF CERTIFIED COPY

Attached please find the certified copy of the foreign application from which priority is claimed for this case:

Country	**: United Kingdom**
Application Number	**: 0122425.2**
Filing Date	**: September 17, 2001**

WARNING: "When a document that is required by statute to be certified must be filed, a copy, including a photocopy or facsimile transmission of the certification is not acceptable." 37 CFR 1.4(f) (emphasis added.)

SIGNATURE OF ATTORNEY
Geza C. Ziegler, Jr.

Reg. No. 44,004

Type or print name of attorney

Tel. No.: (203) 259-1800

Perman & Green, LLP

Customer No.: 2512

P.O. Address

425 Post Road, Fairfield, CT 06430

NOTE: The claim to priority need be in no special form and may be made by the attorney or agent if the foreign application is referred to in the oath or declaration as required by § 1.63.

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8a)

I hereby certify that this correspondence is, on the date shown below, being:

MAILING

☑ deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to the Commissioner of Patents, Washington, D.C. 20231

Date: FEB. 26, 2002

FACSIMILE

☐ transmitted by facsimile to the Patent Office

Deborah J Clark
Signature

DEBORAH J. CLARK
(type or print name of person certifying)

(Transmittal of Certified Copy [5-4]

OIPE JC177
MAR 1 1 2002
PATENT & TRADEMARK OFFICE

The Patent Office

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

#6 D. Scott 7-2-02

RECEIVED
APR - 3 2002
TC 2800 MAIL ROOM

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated -9 NOV 2001

Patents Form 1/77

Patents Act 1977
(Rule 16)

17 SEP 2001 RECEIVED

The Patent Office

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference	PJF01215GB	17 SEP 2001
2. Patent application number *(The Patent Office will fill in this part)*	0122425.2	18SEP01 E660549-1 D02890 P01/7700 0.00-0122425.2
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	Nanyang Technological University School of Electrical & Electronic Engineering Block S2, Nanyang Avenue Singapore 639798	
Patents ADP number *(if you know it)*		
If the applicant is a corporate body, give the country/state of its incorporation		8227704001
4. Title of the invention	AN OPTICAL COUPLING MOUNT	
5. Name of your agent *(if you have one)*	Gill Jennings & Every	
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Broadgate House 7 Eldon Street London EC2M 7LH	
Patents ADP number *(if you know it)*	745002	

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* YES

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	5
Claim *(s)*	2
Abstract	1
Drawing *(s)*	7

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	NO

11. For the applicant
Gill Jennings & Every

I/We request the grant of a patent on the basis of this application.

Signature

Date
17 September 2001

12. Name and daytime telephone number of person to contact in the United Kingdom

FINNIE, Peter John
020 7377 1377

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

AN OPTICAL COUPLING MOUNT

Background to th Inv ntion

There is a great need to couple efficiently the light between a semiconductor edge emitting waveguide device and a single mode optical fibre. In order to achieve significant coupling, it is often necessary to convert the small and severely astigmatic optical mode profile obtained from a semiconductor waveguide device such as a ridge-guided laser, a modulator or a semiconductor optical amplifier, to the concentric and larger modal profile of a single mode fibre. Typically, this modal mismatch results in a coupling loss of between 8 and 10 dB.

Current approaches for achieving such coupling are threefold: (a) employment of a micro-lens system between the device and the fibre, (b) use of a converter fibre, such as a graded refractive index (GRIN) fibre, at the tip of the single mode fibre, and (c) incorporation of a spot size converter with the semiconductor substrate i.e. monolithically integrate the spot size converter and semiconductor laser. The disadvantages of method (a) are those of high cost and complexity of alignment and mounting, of method (b) are those of instability and tight alignment tolerance and of method (c) are the potentially lower device yield resulting from the increased processing difficulties and the added cost of the III-V semiconductor material. In addition, all the above-mentioned approaches suffer from a misalignment problem associated with coupling single mode devices, whereby a 1 dB decrease in coupling efficiency can result for a lateral misalignment of less than +/-0.5μm.

Summary of the Invention

According to one aspect of the present invention, an optical bench for coupling light between an optical device and an optical fibre, the optical bench comprising an integral optical spot size converter and optical alignment means for fixing the position of an initially separate optical device relative to the optical spot size converter so that, in use, light is coupled between the optical device and the optical spot size converter.

In the present invention, we provide an optical bench upon which is located an optical spot size converter and provision for alignment and mounting of a separately formed optical device such that on assembly the spot size converter is in close alignment with the optical device. Accordingly, the present invention provides a simple means for

waveguide. The spot-size at the output facet of the converter, for the design simulated, yielded an 88% modal distribution matching with a single mode fibre and with a high mode conversion efficiency of 97%.

Figure 5 shows the calculated variation in coupling loss with vertical misalignment at the input facet of the spot size converter for three different sizes of ridge laser. The results illustrate that where ridge lasers of width between 3 and 5 μm are considered, it is determined that a misalignment of 0.3 μm would result in a loss of less than 2 dB.

Figure 6 shows the calculated variation in coupling loss with lateral misalignment at the input facet, for the simulations considered in Figure 5. Here the results illustrate that a loss of less than 3dB can be achieved for a misalignment of less than 1.75 μm, which is comparable to other semiconductor monolithically integrated spot-size converters.

Figure 7 shows the provision of a v-groove 30 in the optical bench 31 which can aid in the alignment of an optical fibre 32 when, for instance, butt-coupled to the output facet 33 of the spot size converter 34. Also shown is a semiconductor waveguide device (ridge laser) 35 which provides the input light to the spot size converter 34. Figure 8 is plan view of Figure 7 and shows the relative positioning, on the optical bench 40, of the optical fibre 41, semiconductor waveguide device 42 and spot size converter 43, including the lower waveguide 44 and upper waveguide 45 of the spot size converter 43. Also shown are the aids to alignment including: the v-groove 46, the trench 47, the alignment grooves 48 and some additional alignment marks 49.

Figure 9 shows a symmetrical variant of the embodiment illustrated in Figure 8 to provide for fibre to waveguide device to fibre coupling. Located on the optical bench 50 are the two optical fibres 51, the waveguide device to which they are to be coupled 52, and two spot size converters 53, including the lower waveguides 54 and upper waveguides 55 of the spot size converters 53. Also shown are the aids to alignment including: two v-grooves 56, a trench 57, alignment grooves 58 and some additional alignment marks 59. The embodiment shown in Figure 9 has many applications where the propagation of light in a fibre has to be interrupted for the purposes of amplification or modulation.

CLAIMS

1. An optical bench for coupling light between an optical device and an optical fibre, the optical bench comprising an integral optical spot size converter and optical alignment means for fixing the position of an initially separate optical device relative to the optical spot size converter so that, in use, light is coupled between the optical device and the optical spot size converter.

2. An optical bench according to claim 1, formed of a silicon material.

3. An optical bench according to claim 1 or claim 2, in which the spot size converter comprises a pair of waveguides, at least one of which is dimensioned so as to cause light preferentially to couple from one waveguide to the other as light propagates along the length of the waveguide.

4. An optical bench according to any preceding claim, in which the spot size converter comprises an upper waveguide having a reducing lateral taper along at least part of its length, vertically spaced a distance above a non-tapering lower waveguide.

5. An optical bench according to claim 4, in which the upper waveguide and lower waveguide are separated by a cladding region.

6. An optical bench according to any preceding claim, in which the optical alignment means is adapted to receive the optical device.

7. An optical bench according to any preceding claim, in which the optical alignment means is keyed for engagement with the optical device.

8. An optical bench according to any preceding claim, in which the optical alignment means comprises at least one trench in the optical bench within which the optical device is to be located and one or more alignment grooves or ridges that cooperate with corresponding alignment ridges or grooves, respectively, formed on the optical device.

9. An optical bench according to any preceding claim, further comprising an integral

V-groove dimensioned to allow for the location of an optical fibre adjacent a facet of the spot size converter.

10. An optical assembly comprising an optical bench according to any preceding claim in combination with an optical device located on the optical bench, and an optical fibre, each of the optical device and the optical fibre being aligned with the spot size converter to provide coupling of light between the optical device and the optical fibre.

11. An optical assembly according to claim 10, in which the optical device is a semi-conductor edge emitting waveguide device.

12. An optical bench or optical assembly substantially as shown in and/or described with reference to any of Figures 1 to 9 of the accompanying drawings.

ABSTRACT

AN OPTICAL COUPLING MOUNT

An optical coupling mount for use in coupling light between a semiconductor waveguide device and an optical fibre comprises a silica based spot size converter (3) located on an optical bench (1) with a trench (8) and grooves (9), whereby the semiconductor device (2) can be positioned in close alignment with the spot size converter (3). The spot size converter (3) comprises a tapered upper waveguide (4) located above a non-tapered lower waveguide (6). The dimensions of the spot size converter (3) are such that a semiconductor device emitting a small, astigmatic optical beam can be efficiently coupled to a single mode fibre requiring a larger, concentric beam.

[Figure 1]

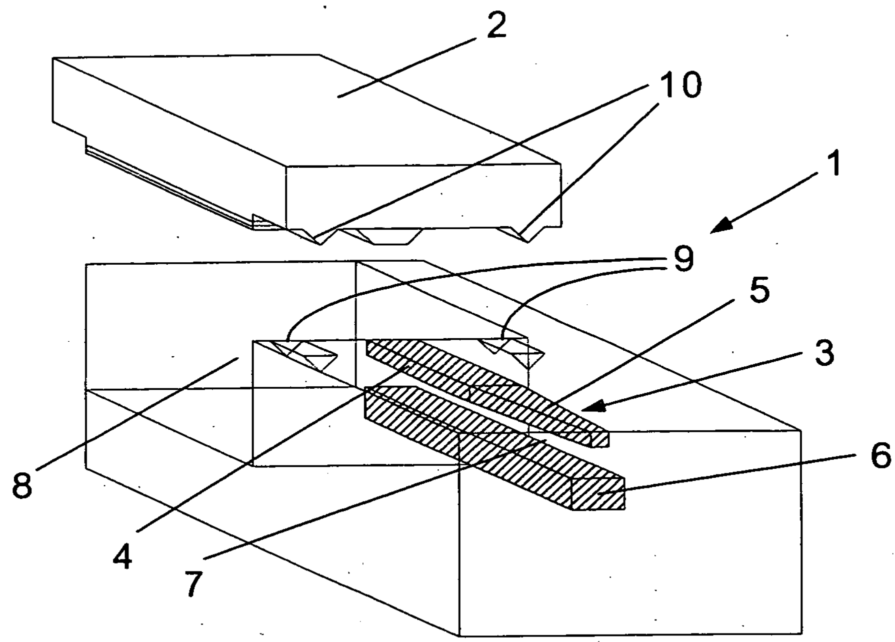

Figure 1

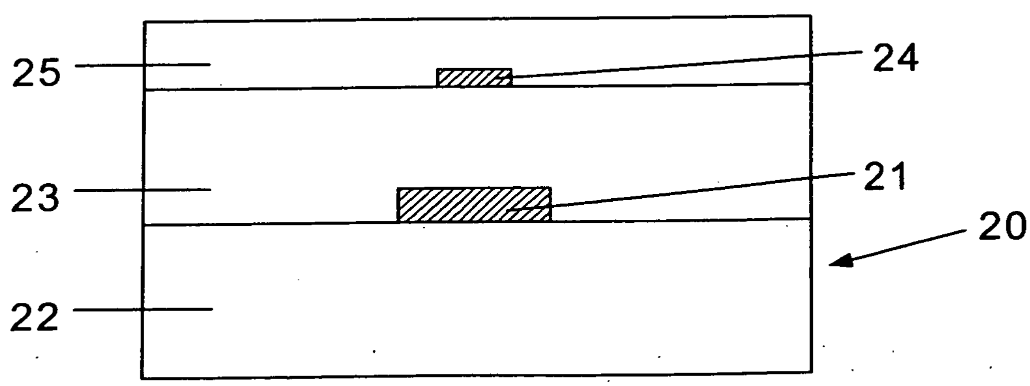

Figure 2

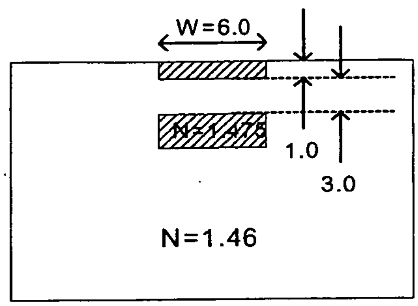

Figure 3A

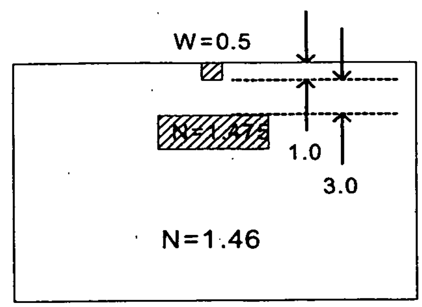

Figure 3B

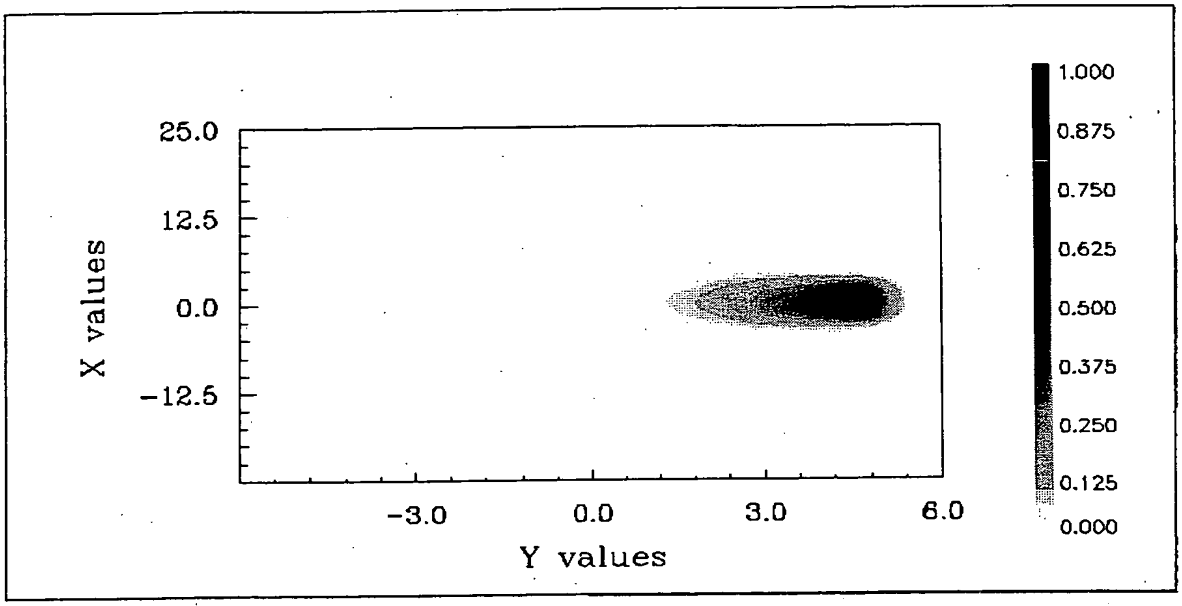

Figure 4A

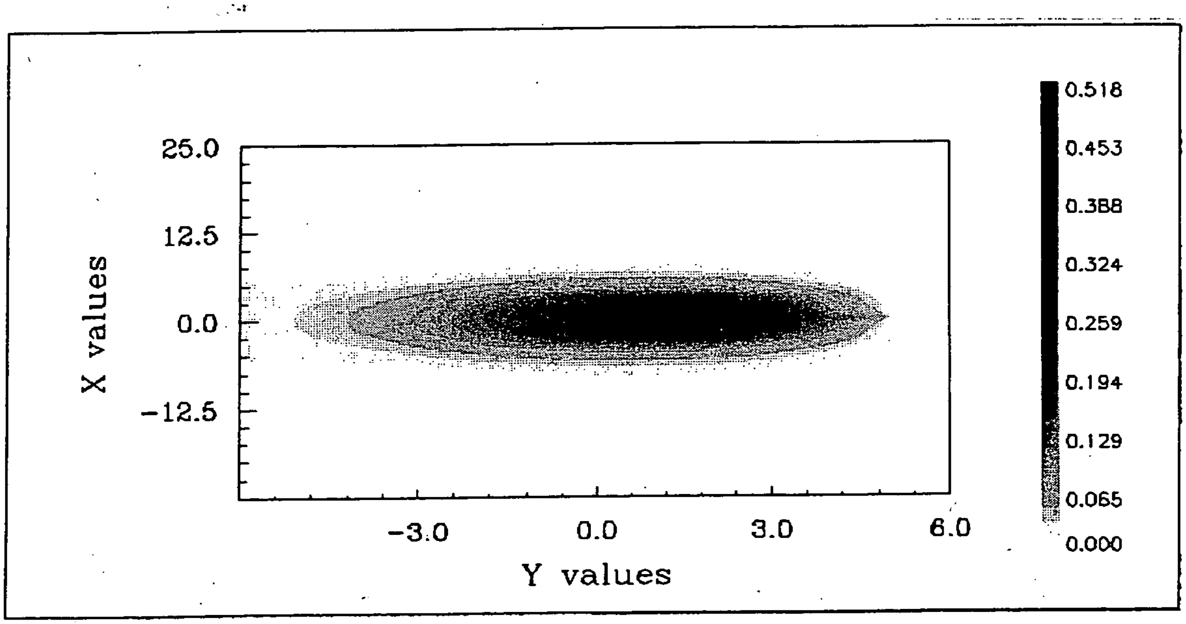

Figure 4B

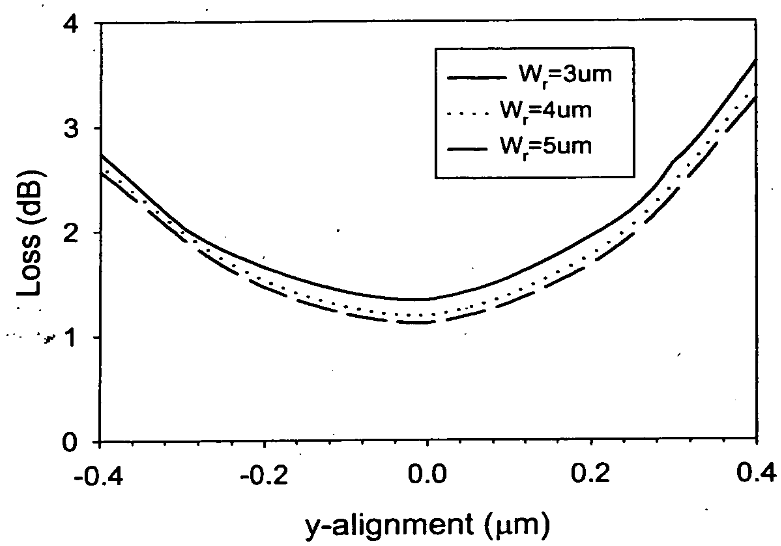

Figure 5

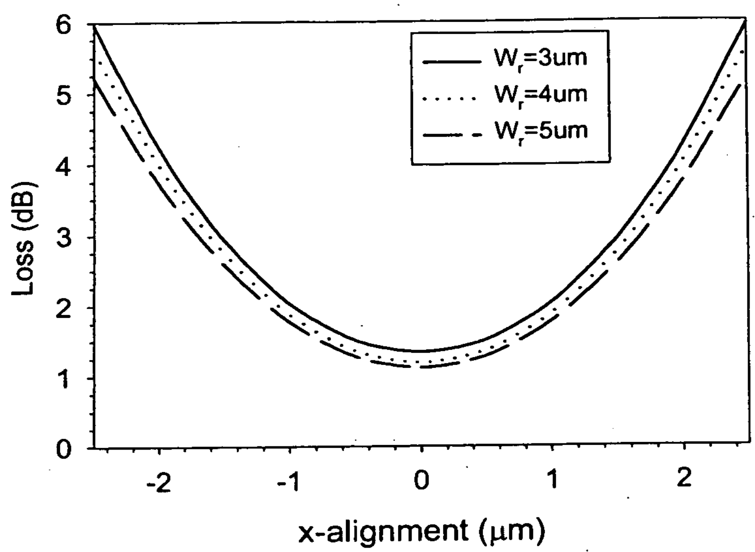

Figure 6

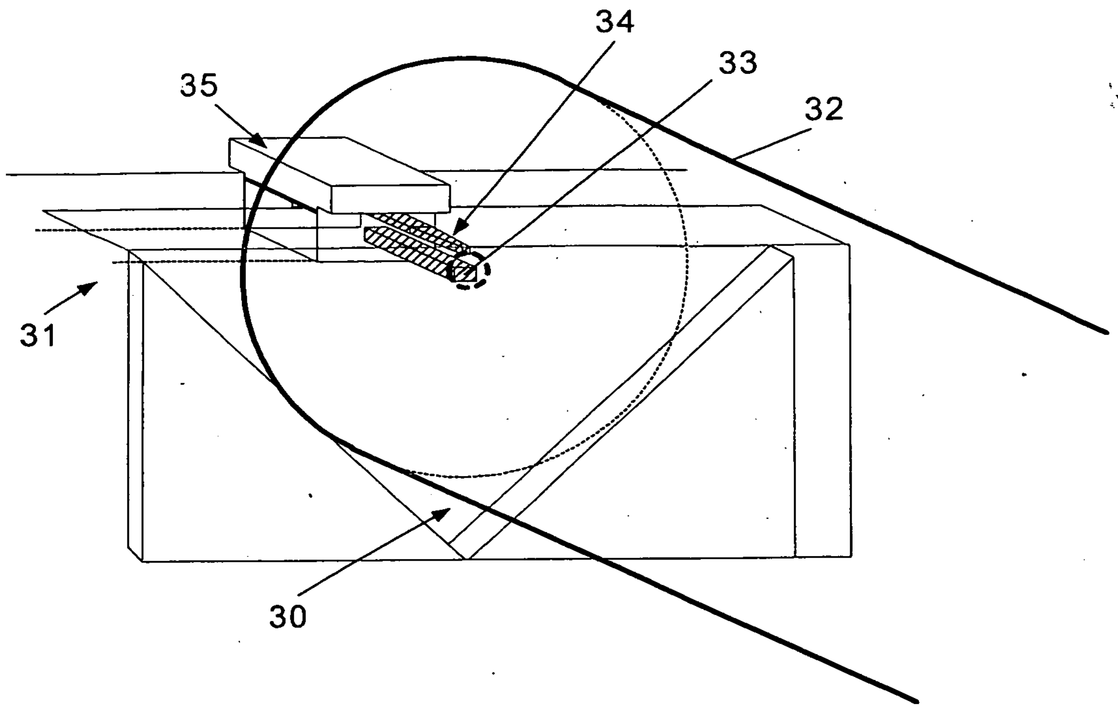

Figure 7

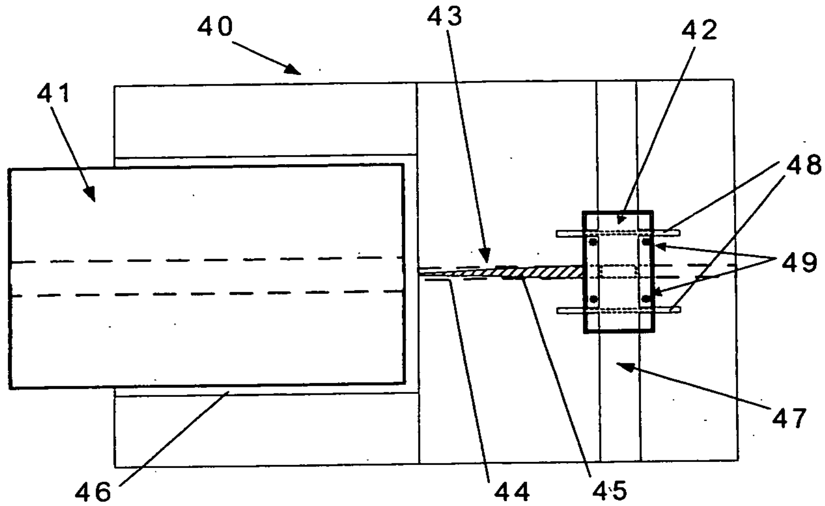

Figure 8

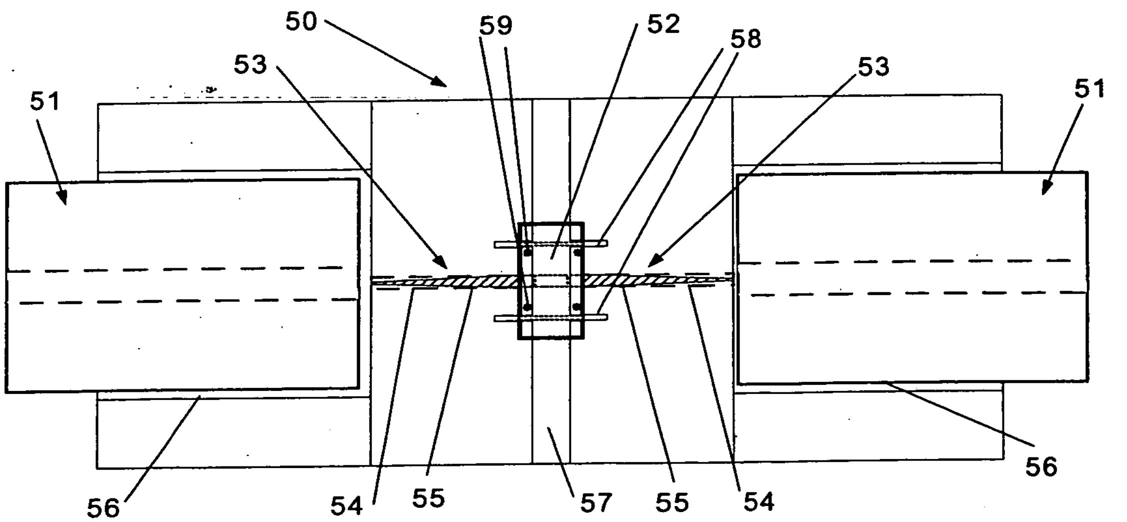

Figure 9